REMARKS

35 U.S.C. §103(a)

Applicants assert that the invention as claimed in the independent Claim 1 is not rendered obvious by the prior art and not by Terao, by Davis or by Yamaoka, whether alone or in combination.

The invention as claimed in independent Claim 1 discloses a method for supporting and positioning a payload effecting simultaneous vibration isolation and large force and stroke position actuation comprising the steps of supporting the payload on a gas piston, commanding gas pressure applied to the gas piston with a pneumatic servo-valve, measuring the error in pressure resulting upon the gas piston, and applying a magnetic force in parallel to the resulting pressure in proportion to the measured pressure error.

The Terao device is only an actuator, not an isolator. It is a position actuator comprising a ball screw operating in mechanically conjoined position with an air piston. The Terao device does not teach a method for supporting and positioning a payload such that vibration isolation and large force and stroke position actuation is simultaneously achieved, as does the present invention. Particularly, the Terao device does not teach or suggest a method that incorporates the application of an error correcting magnetic force to the commanded gas pressure applied to a gas piston, as does the present invention. The Terao device teaches that a refined positioning of a payload may be achieved through the combination of a ball screw in mechanically conjoined operation with a pneumatic actuator. The construct and concept of the Terao device, through the combination of a

ball screw with the pneumatic actuator, precludes the possibility of applying a magnetic force in parallel to the resulting pressure in proportion to the measured pressure error.

The Davis device is an isolator, and in structure and concept only a very modest stroke actuator. Davis does not disclose a pneumatic actuator or disclose or teach an actuation method providing any significant stroke relative to the size of the device. Large displacement actuation is not available within the concept of the device since actuation is gained only through the fluid pressurization and modest fluid movement offered by the internal electromagnetic actuator. The possible motion available by this approach is further constrained by the D-shaped flexure piece which forms essential part of the damping fluid chamber. As a result, the Davis device actuation performance is substantially limited due to the opposed needs of limiting the size and stiffness of the D-shaped flexure so to provide lower frequency vibration isolation versus the need for increasing the D-shaped flexure stiffness so to provide greater load carrying capability.

Applicants assert that alone or in combination, Terao and Davis do not teach or suggest a method for supporting and positioning a payload such that vibration isolation and large force and stroke position actuation is simultaneously achieved, as does the present invention.

The teaching of Davis is that an electromagnetic actuator can vary the pressure of the damping fluid used within an otherwise passive damping mechanism. Within Davis there is no teaching or suggestion of applying a magnetic force in parallel to the resulting pressure of a commanded gas pressure where that pressure is applied to a gas piston, and further there is no teaching or suggestion of applying a magnetic force in proportion to the measured pressure error applied to the gas piston.

Examiner states that Terao differs only in the type of magnetic actuator that is used and that it would have been obvious to use a linear motor in place of the rotational motor used to drive the ball screw. Applicants argue that it is neither correctly nor simply a matter of substitution of a linear magnetic motor for a rotational one that distinguishes the present invention from Terao and Davis. The Terao device manages relative displacements, and the substitution suggested would simply result in a linear motor driven ball screw. The incorporation of a ball screw with a pneumatic actuator for obtaining refined positioning capability prevents one from achieving significant vibration isolation, and the recognition of the constraints on performance incurred within the Terao device by this combination is of questionable obviousness in and of itself.

Applicants assert that to perceive how one modifies a Terao device, a refined position control actuator utilizing a ball screw conjoined with a pneumatic piston, with attributes of the Davis device, where a magnetic actuator modifies the fluid pressure of passive damper, to get the attributes of the present invention is not obvious.

It is the application and management of applied force to a payload that makes the present method unique and non-obvious. The prior art speaks to position control within actuators, as in Terao, or damping modification within otherwise passive isolators, as in Davis. The prior art does not combine to teach or suggest a method of force control that achieves large stroke and force position actuation with simultaneous vibration isolation, as does the present invention.

The Terao device does not control the applied supporting force, which supports the payload; it only controls the relative position of the payload to its support. The mechanical displacement applied by the ballscrew, even though driven by an electric

motor, is not equivalent in form, function, or capability to the application of a magnetic force in parallel to a commanded pressure. In the present invention, the application of a magnetic force, without the accompanying stiffness and inertia of a ball screw and motor or the like, allows for pressure force correction as necessary for precise large force and stroke positioning simultaneous with vibration isolation.

The Terao device in its application of a ball screw to fine position a piston, cannot make the applied dynamic force as large or as small as necessary to effectively isolate the workpiece or payload from vibrations in the mounting base of the device, as does the present invention. Further, Davis, in its use of a magnetic actuator for damping pressure modulation, does not teach or suggest the application of a magnetic force in parallel to the resulting pressure, of a commanded gas pressure, in proportion to the measured pressure error. The present invention is not obvious from Terao in light of Davis.

Terao, instead of applying a purely magnetic force such as through a magnet and coil, incorporates a ball screw and the ball screw applies an indeterminate mechanical force to the piston based on the desired workpiece position. The air piston initially positions and supports the static load of the table and any attached workpiece. The ballscrew then provides the final positioning of the workpiece. The Terao device, in using the ball screw to engage and provide final position of the piston and workpiece, suffers from the inherent stiffness of, and inability to backdrive the ballscrew. These attributes coupled with the low dynamic force response of the drive motors and pulleys prevent the Terao device from providing any significant vibration isolation capability. Terao could not produce a position output that would accurately track an input signal if a

command waveform called for it to move back and forth over a significant distance at a rate of more than, at most, a few cycles per second.

Because of these features of the Terao device and to its significant limitation, the Terao device positions its workpiece regardless of the body accelerations that may exist on the workpiece or the dynamic displacement disturbances at the base of support for the device. Because of the stiffness of the load path through the ball screw, the Terao device transmits whatever dynamic displacement disturbances the base experiences onto the workpiece.

Of particular note, device actuation state variable control, and particularly overall device output force control, is not provided by the Davis device and Davis is not instructive on how such control could be implemented onto the Terao device. It is accepted by Applicants as obvious that an electromagnetic actuator can be used to vary the position of one component relative to another in precise and broad frequency fashion. Applicants assert, however, that it is not obvious how one employs the characteristics of an electromagnetic actuator onto the Terao device to obtain the present invention or equivalent capabilities of the present invention. Applicants further assert that an electromagnetic actuator and motor driven ballscrew cannot serve as equivalents within vibration isolation devices, and therefore substitution of one for another would not be obvious. It is further not apparent how the vibration isolation capability of Davis could be imparted to the actuation ability of Terao.

The method of the presently claimed invention affords significantly larger payload carrying capability, higher accuracy dynamic position actuation capability, as well as significant broadband vibration damping and isolation ability beyond the state of

the prior art. The method of the presently claimed invention affords the tracking of a force command at rates of 20-40 cycles per second. The Davis device discloses a passive damping device that relies on arc shaped mechanical spring elements to support the isolated payload, thereby significantly limiting its load carrying ability. Further, the position actuation capability of Davis is limited to the modest loads and strokes afforded by the electromagnetic actuation portion of the device. The Terao device claims no isolation ability, and inherently has little effective vibration isolation capability, and incorporation of isolation features of Davis is not obvious. The Applicants assert that notwithstanding the conceptual distinctions drawn, that the presently claimed invention as claimed in independent Claim 1 is non-obvious based on its distinct and marked improvement in performance relative to methods or devices of the prior art.

Yamaoka discloses an electromagnetic strut and discloses nothing addressed to vibration isolation. The Yamaoka device uses electromagnetics to generate the entire force developed by the device and incorporates no passive means for transmitting force from one end of the device to the other. Yamaoka does not teach or suggest anything in regard to applying a magnetic force in parallel to the resulting pressure of a commanded pressure applied to a gas piston in proportion to the measured pressure error.

Because of the above described distinct, novel, and non-obvious differences of the present invention relative to Terao, Davis, and Yamaoka, and because of the significant performance advantages and improvements provided by the present invention relative to the prior art, Applicants assert that the present invention as claimed in independent Claim 1 is not obvious in light of the prior art and is not obvious in light of Terao, Davis, and Yamaoka when considered alone or in combination.

CONCLUSION

For the above reasons, the present invention as claimed in the original and unamended independent Claim 1 is not anticipated and is not obvious in light of the prior art. Dependent claims 2-6 remain allowable as being dependent upon allowable base Claim 1.

Accordingly, Applicants respectfully submit that all the claims as originally submitted are in condition for allowance, and such action is earnestly solicited.

Respectfully submitted,

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